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ORIGINAL ARTICLE

Determinants of Hypertensive Disorders of Pregnancy in Rural Women in Central India: A Community-Based Cohort Study

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Abstract

Objective This prospective cohort study was planned to elucidate the magnitude and epidemiological determinants for hypertensive disease in pregnancy (HDP) in a cohort of rural women of central India.

Methods It was a community-based prospective cohort study of rural pregnant women. 1650 eligible women were recruited at less than 20 weeks of gestation by pretrained field workers in 100 villages of Wardha District. Baseline socio-demographic factors of all subjects were recorded with the help of open-ended pre-designed and tested questionnaire. They were screened for high risk factors. The woman was followed up till delivery for development of hypertensive disorder of pregnancy.

Result The overall incidence of hypertensive disorders in pregnancy was 7.15%. On univariate analysis, significant determinants of HDP were education, occupation, socio-economic status, interval from previous pregnancy, BMI, calcium intake, stress, and family history of hypertension. Odds of HDP increased by 1.075 times with every additional year of age (95%CI: 1.001 to 1.154), by 1.165 times if BMI increases by one unit (95%CI: 1.165 to 1.168), by 1.168 times if stress score increases by one (95%CI: 1.091 to 1.252), and reduced by 0.736 if haemoglobin increases by one gm/dl (95%CI: 0.632 to 0.858). Family history of hypertension doubles the odds of HDP (95%CI: 1.075 to 3.813).

Conclusions This study helped us to know the burden and various epidemiological determinants of hypertensive disorders. It helped us in identifying the modifiable high risk factors that stakeholders should give due attention to formulate preventive strategies for improving obstetric outcome.

Keywords Hypertensive disorders of pregnancy · Maternal · Neonatal · Outcome

Introduction

Pregnancy is physiological event that may sometimes be complicated by pathological process, hypertensive disorders of pregnancy (HDP) being one of them. Hypertensive disorder complicating pregnancy is one amidst the lethal triad accompanying haemorrhage and infection that results in considerable number of maternal mortality. HDP comprise chronic hypertension, gestational hypertension, preeclampsia, and eclampsia, attributing for a prevalence of around 5% to 10% in the procreative population [1]. HDP accounts for about 76,000 maternal and 500,000 perinatal deaths globally per year [2]. A multicentre study conducted in India, Nigeria, Pakistan, and Mozambique demonstrated the prevalence of HDP to be around 10% [3]. The incidence of preeclampsia in hospital practice in India ranges between 5 and 15% while that of eclampsia is around 1.5% [4]. Research from our country indicates that HDP may lead to up to one-third of maternal mortality [5].

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HDP escalates adverse neonatal outcomes such as preterm birth, still birth, small for gestational age and neonatal death [6]. Demographic, family, medical history, current pregnancy and paternal variables are all risk factors for HDP. Risk assessment of these factors for development of HDP can aid in pinpointing women who warrant enhanced surveillance and therapy. Pregnancy-specific hypertensive disorder is unpredictable in onset and progression. Only cohort design can adequately capture the dynamic character of numerous risk factors and their relationships in time to disease occurrence.

Therefore, this prospective study aims to measure the incidence and establish demographic and clinical determinants for development of HDP in a cohort of rural women of central India.

Materials and Methods

Study Design and Setting

The study was carried out in 100 villages of Wardha district in Central India in 3 Primary Health Centres (PHCs) within 50 km radius. The study team established a cohort of 1650 pregnant women over a period of 3 years. The total population covered was approximately 100,000. The study was conducted from January 2016 to December 2019.

Study Population

The research workers obtained details about new pregnancies in the designated area from the frontline workers of that particular village. The pretrained field workers enrolled all the women who become pregnant during the study period and consented to be a part of the study. The women were followed up monthly till 9 months. Those developing hypertension were referred to higher centre for further investigations and treatment. They were followed till 1 month post-delivery to study the maternal and neonatal outcome.

Inclusion Criterion

Women who were less than 20 weeks during the study period in the designated area and consented to be a part of the study.

Exclusion Criterion

-Women with preexisting diseases like chronic renal disease and autoimmune disorders like Systemic Lupus Erythematosus (SLE).

-Women who did not give consent to be a part of the study.

Variables of the Study

A. Dependent: HDP.

B. Independent:

Demographic variables: Age, Education, Occupation, Religion, socioeconomic status.

Obstetric factors: Gravida. Parity, interpregnancy interval ANC follow-up.

Medical Disease factors: Pre-existing hypertension, Family history of hypertension, anaemia.

Personal factors: Stress, Body Mass Index and Calcium Intake.

The variables were determined based on existing literature and similar studies.

Data Collection

Methodology

To evaluate determinants of HDP we used a structured questionnaire for recording baseline socio-demographic characteristics and pregnancy-related parameters. Baseline blood pressure was measured using sphygmomanometers. Albustix was used to look for proteinuria. Body mass index of the women was measured. Monthly visits were made by field workers to follow up these women for blood pressure measurement and urine albumin. Once the field worker established a rapport with the patient and family, the level of stress in the pregnant females was measured by the "Perceived Stress Scale" for pregnant women. The scale was translated to the local language and filled up by the patient herself. If the patient was illiterate, the scale was filled up by the field worker. The maximum score is 40 and there are 3 categories as per the score: low (0–13), moderate (14–26) and high (27–40). PSS-10 is a corroborated tool of subjectively perceived stress levels over the past month. Around 28 weeks, the dietary intake of calcium was recorded by 24-hour dietary recall method. These interviews were conducted either in the woman's house or in the near-by Anganwadis as per the convenience of woman. The woman was followed up till delivery for development of hypertensive disorder of pregnancy.

Quality checks: The data with all the details were entered in the computer on everyday basis. Post-coding was done for responses. Any short-comings were corrected by continuous monitoring and analysis, and a quality check was done periodically by the investigators.

Sample Size Calculation and Sampling

We calculated the sample size requirements using prior studies which have shown results as below:

Risk factors	RR	CISSS
Nulliparity	2.38	2.28–2.49
Maternal age ≥ 35 yrs	1.67	1.58–1.77
Family history	2.90	1.7–4.93
Raised BMI	2.47	1.66–3.67

After using these estimates and considering $\alpha = 0.5$ and power of 80%, sample size was estimated to be 1500. Population here is agriculture based and has minimum migration. Hence, the attrition was expected to be minimum so we added 10%, i.e. 150 more to the sample size making it 1650.

Sample size was calculated by utilizing the formula:

$$\eta = \frac{\left\{ Z_{1-\alpha/2}\sqrt{2}P(1-P) + Z_{1-\beta}\sqrt{P_1}(1-P_1) + P_2\left(1-P_2\right) \right\}^2}{\left(P_1 - P_2\right)^2}$$

$$P = \frac{\left(P_1 - P_2\right)}{2}$$

Tests for Statistical Analysis

1650 eligible women were recruited.

Data were analysed using SPSS software. Relative risks with 95% confidence intervals were computed. Multivariate logistic regression analysis model was used for analysis of variables.

Results

1650 eligible women were studied. In our study, the magnitude of HDP was 7.2% (95%CI: 5.9% to 8.4%) (Table 1). Median gestation of diagnosis of HDP was 35.5 weeks (IQR: 34 to 36 weeks). Out of the 1650 mothers included in the study, 585 (35.5%) were below 22 years of age while 283 (17.1%) were above 26 years of age. Although not statistically relevant, the incidence of HDP was greatest among women above 26 years (9.2%) ($p = 0.415$).

1.3% mothers were illiterate and majority (76.7%) mothers had completed secondary schooling. The incidence of HDP was significantly higher among postgraduates (20%) as compared to those with lower education levels ($p = 0.018$). Among the study population, majority (68.6%) mothers were housewives and 23.7% mothers were engaged in unskilled work. Our study found a notable relation between occupation and HDP ($p = 0.029$). Professionals and businesswomen had a greater incidence (22.2% and 16.2%, respectively) of HDP although the majority of patients were housewives (68.6%). The current study used "Udai Pareek scale" for determining the socioeconomic status of concerned population. There was no substantial connection between socio-economic status and HDP ($p = 0.808$) as well as between religion and HDP ($p = 0.521$).

41.9% and 41.0% mothers of the study population were gravida 1 and gravida 2; however, higher incidence of HDP was found among women with Gravida > 4 (9.4%) as compared to primigravidas (7.8%) although this was not statistically relevant ($p = 0.664$). In our study, 28.4% of the study population was thin (chronic energy deficiency), while 12.8% mothers were overweight/obese. However, incidence of HDP was 14.2% among obese population as compared to only 3.6% among thin population and this difference was statistically significant (p less than 0.001). 13.6% of mothers with HDP had a family history of hypertension whereas only 6.7% did not have a family history, this difference being statistically significant ($p = 0.009$).

In our study, 76.7% mothers were anaemic. However, incidence of HDP was 7.3% among those with haemoglobin less than 110 g/L and 6.5% among those with haemoglobin more than 110 g/L and this was not statistically relevant ($p = 0.578$). In our study, only 4(0.2%) mothers consumed calcium less than 500 mg/day but 2 of them developed HDP. Incidence of HDP had an inverse relationship with calcium intake being 50%, 9.3%, 7.1% and 5.6% in women consuming less than 500 mg, 500–1000 mg, 1000–1500 mg and 1500–2000 mg, respectively. Thus, there was a statistically significant difference between incidence of HDP and calcium intake ($p = 0.004$).

Stress had a significant association with incidence of HDP ($p = 0.047$). Mothers with stress score in the 1st quartile had a 5.1% incidence of HDP as compared to mothers in the 4th quartile who had an incidence of 10.4%. The largest chunk of the study population was that of primigravida (50.3%). 11.9% of the mothers had an interpregnancy interval more than 44 months and the incidence of HDP was highest among this group being 10.7%, this being statistically relevant ($p = 0.011$). On univariate analysis, significant determinants of PIH were education, occupation, socio-economic status, interval from previous pregnancy, BMI, calcium intake, stress, and family history of hypertension (Table 1).

Final model for determinants of PIH was derived using multivariate logistic regression. Here, instead of categorising variables into different categories, continuous variables were used in its original form. As per the final model, significant determinants of PIH were age of the mother, BMI, stress,

Table 1 Determinants of hypertensive disorders of pregnancy (HDP): univariate analysis

Variable	Category	Number studied N = 1650 (%)	Numbers with PIH	Percentage with PIH	*p* value
PIH	Overall	1650	118	7.2 (5.9–8.4)	–
Age in years (quartiles)	First (< 22 years)	585 (35.5)	36	6.2	0.415
	Second (22–24 years)	424 (25.7)	32	7.5	
	Third (25–26 years)	358 (21.7)	24	6.7	
	Fourth (> 26 years)	283 (17.1)	26	9.2	
Education	1)Illiterate	22 (1.3)	3	13.6	0.018
	2)Primary	136 (8.2)	10	7.4	
	3)Secondary	1268 (76.7)	86	6.8	
	4)Graduate	183 (11.1)	11	6.0	
	5)Post graduate	41 (2.5)	8	20.0	
Occupation	1)Housewife	1132 (68.6)	70	6.2	0.029
	2)Unskilled worker	391 (23.7)	32	8.2	
	3)Semi-skilled/Skilled worker	81 (4.9)	8	9.9	
	4)Business	37 (2.2)	6	16.2	
	5)Profession	9 (0.5)	2	22.2	
Religion	1)Hindu	1450 (87.9)	106	7.3	0.521
	2)Buddhist	170 (10.3)	9	5.3	
	3)Muslim	30 (1.8)	3	10.0	
Socio-economic status	Low	989 (59.9)	68	6.9	0.808
	Middle	516 (31.3)	38	7.4	
	Upper	145 (8.8)	12	8.3	
Gravida	1	692 (41.9)	54	7.8	0.664
	2	676 (41.0)	43	6.4	
	3	218 (13.2)	15	6.9	
	> 4	64 (3.9)	6	9.4	
Interval from previous pregnancy	Primiparous	830 (50.3)	64	7.7	0.011
	< 20 months	213 (12.9)	8	3.8	
	21–29 months	206 (12.5)	7	3.4	
	30–43 months	204 (12.4)	18	8.8	
	> 44 months	197 (11.9)	21	10.7	
BMI	Thin	469 (28.4)	17	3.6	< 0.001
	Normal	970 (58.8)	71	7.3	
	Overweight/obese	211 (12.8)	30	14.2	
Calcium	1) < 500 mg	4 (0.2)	2	50.0	0.004
	2)500–1000 mg	183 (11.1)	17	9.3	
	3)1000–1500 mg	1141 (69.2)	81	7.1	
	4)1500–2000 mg	322 (19.5)	18	5.6	
Stress score (Quartile)	First (< 14)	448 (27.2)	23	5.1	0.047
	Second (15–16)	400 (24.2)	26	6.5	
	Third (17–19)	494 (29.9)	37	7.5	
	Fourth (> 20)	308 (18.7)	32	10.4	
Family history of hypertension	Yes	110 (6.7)	15	13.6	0.009
	No	1540 (93.3)	103	6.7	
Haemoglobin	< 110 gm/L	1266 (76.7)	93	7.3	0.578
	> 110 gm/L	384 (23.3)	25	6.5	

Haemoglobin level, and family history of hypertension. Odds of PIH increased by 1.075 times with every additional year of age (95%CI: 1.001 to 1.154), by 1.165 times if BMI increases by one unit (95%CI: 1.165 to 1.168), by 1.168 times if stress score increases by one (95%CI: 1.091 to 1.252), and reduced by 0.736 if haemoglobin increases by one gm/dl (95%CI: 0.632 to 0.858). Family history of hypertension doubles the odds of PIH (95%CI: 1.075 to 3.813) (Table 2).

Discussion

Early detection of HDP and prompt treatment helps to reduce morbidity and mortality due to this condition. Antenatal care detects imminent signs in high risk pregnancies, and this helps in early diagnosis and reduction in severity. Since the aetiology of this disease is uncertain with diversity of factors, there is no exclusive gene to explicate the disorder and no single 'magic bullet' for treating this condition. It is heartening that identification of maternal predisposition to the disorder can direct remedial treatment for prevention of hypertensive disorders in specific target in some subsets of women [7]. HDP is a major contributor for maternal and neonatal complications and study of its determinants both modifiable and non-modifiable can go a long way in reducing these complications. In a developing country like India, where more than half of the population resides in rural areas universal antenatal care is an uphill task, detection of these high risk factors can help in increased surveillance and care at tertiary institutes. This is important because at the village level, routine antenatal care is still largely being provided by ASHA workers, ANMs or at the most medical officers who are not equipped to handle high risk cases.

Our study found the magnitude of HDP to be 7.2%. A prospective population-level survey in Mozambique, Nigeria, Pakistan and India established prevalence of HDP as 10.9%, 10.2%, 9.3% and 10.3%, respectively [3]. A study carried out in western India showed that prevalence of HDP was 7.8% which is similar to our findings [8].

This being a predominantly rural and agricultural population the prevalence of pre-existing hypertension and diabetes mellitus is low, however, due to problems of poverty, malnutrition and poor obstetric facilities, lack of antenatal awareness the health seeking behaviour of antenatal women is delayed and thus the median gestational age at diagnosis is delayed. We found the median gestation of diagnosis of HDP to be 35.5 weeks (IQR: 34 to 36 weeks).

Table 2 Determinants of HDP using multivariate logistic regression

Variable	Odds ratio (95% CI)	*p* value
Age of the mother	1.075 (1.001–1.154)	0.047
BMI	1.165 (1.096–1.239)	< 0.001
Stress	1.168 (1.091–1.252)	< 0.001
Haemoglobin	0.736 (0.632–0.858)	< 0.001
Family history of PIH	2.025 (1.075–3.813)	0.029

More than three-fourths of the study population (82.9%) was below the age of 26 years. Majority of women in our population were less than 22 years (35.5%) because there is a trend of early marriage and early conception in our geographical area. Only 283 (17.1%) mothers were above 26 years of age and the incidence of HDP was greatest among these women above 26 years (9.2%) but this was not statistically valid ($p = 0.415$). Similar findings were found in a study carried out at Nekemte Referral Hospital at Ethiopia which showed that the extreme ages were associated with HDP with greater incidence among age more than 35 years as compared to 25–29 years [9]. In a study conducted at Jhalawar [10], most of the hypertensive patients were between 25 and 30 years (53.75%.).

Only 2.5% of the women in our study had completed postgraduation. Majority (76.7%) of the population had completed secondary education. However, incidence of HDP was significantly higher among postgraduates (20%) as compared to those with lower education levels ($p = 0.018$). In a study carried out in Thiruvalla, Kerala, incidence of HDP was found to be higher among women who had completed graduation or higher, although the difference was not statistically significant [11]. This is similar to findings seen in our study. Higher incidence of HDP among educated women could be attributed to stress related to their multiple roles at home and work front. In contrast to our study, higher incidence of HDP was found among illiterate women (51%) in a study carried out at a tertiary care hospital in Jhalawar, Rajasthan [10]. This could be attributed to delayed health seeking behaviour due to lack of education.

In our study, a large chunk (68.6%) of the population was that of housewives, prevalence of HDP among them was 6.2%. Only 2.2% and 0.5% of the population were businesswomen and professionals, respectively; however the prevalence of HDP among them was 16.2% and 22.2%, respectively, and this was statistically relevant ($p = 0.029$). In a study carried out at three public sector hospitals at Bangalore, it was found that employed women had double risk of suffering from hypertension in comparison with homemakers, which is similar to our study [12]. In contrast to our study, in a study carried out at Kerala [11] and at seven public hospitals in Ethiopia in Tigray region [13], no significant association was found between occupation and incidence of HDP. Occupation-related stress could be the reason for this difference in prevalence of HDP.

Our study showed no relation between socioeconomic status and prevalence of HDP ($p = 0.808$). This is similar to studies carried out at Kerala [11] and Bangalore [12].

However, another study carried out at Jhalawar [10] found a higher incidence of HDP among lower socioeconomic status. Efforts to improve female literacy and bring about awareness regarding the importance of antenatal care could go a long way in reducing the incidence of hypertensive disorders in pregnancy.

No association was found between parity and HDP in our study population ($p = 0.664$). This finding is similar to that of meta-analysis carried out by Dhinwa et al. [8]. The study carried out at Bangalore [12] also showed no association between parity and HDP.

In our study, incidence of HDP was 14.2% among obese population as compared to only 3.6% among thin population and this difference was statistically significant (p less than 0.001). As per the study carried out at Bangalore [12], risk of HDP was more than twice as higher among obese pregnant women than nonobese. Similar findings were found in study carried out at Ethiopia in Tigray region [13] and in a meta-analysis carried out at Ethiopia [14]. This finding is significant as there is a growing pandemic of obesity even in developing countries like India. The general population needs to be made aware about the ill effects of obesity during pregnant as well as non-pregnant state.

In our study, those with a family history of hypertension (13.6%) were almost twice as likely to develop HDP as compared to those who did not and this was statistically relevant ($p = 0.009$). In the study carried out at Nekemte Referral hospital in Ethiopia, a family history of hypertension had a significant association with HDP [9]. Similarly, in a study carried out at a tertiary hospital in South Kerala, significant association was found between HDP and family history of hypertension [11].

Majority of mothers in our population were anaemic (76.7%). Although the incidence of HDP was greater amongst those with anaemia (7.3%) in comparison with those with haemoglobin more than 110 g/L (6.5%), this was not statistically valid ($p = 0.578$). This is in contrast to a study carried out using data from the World Health Organization Global Survey for Maternal and Perinatal Health which showed a significant association between anaemia and hypertensive disorders of pregnancy [15].

Incidence of HDP had a statistically significant inverse relationship with calcium intake being 50%, 9.3%, 7.1% and 5.6% in women consuming less than 500 mg, 500–1000 mg, 1000–1500 mg and 1500–2000 mg, respectively ($p = 0.004$). This is similar to a findings of an unmatched case–control study done at Ethiopia which showed a significant association between low dietary calcium intake and preeclampsia [16].

In our study, mothers with stress score in the 4th quartile had an incidence of 10.4% as compared to those with stress score in first quartile who showed an incidence of 5.1%. Hence, stress had a significant association with incidence of HDP ($p = 0.047$). This finding is similar to study carried out at Bangalore [12] which showed that pregnancy-related anxiety was a positive predictor of hypertension. A presumptive vindication is that stress while pregnant is constantly related to dysregulation of the hypothalamo–pituitary–adrenal (HPA) axis, leading to a high endogenous cortisol amount that gives rise to endothelial dysfunction.

Amongst our study population, women with interpregnancy interval > 44 months had a higher incidence of HDP (10.7%) as compared to primipara (7.7%) and those with short interpregnancy interval (3.2%) and this was statistically valid ($p = 0.011$). This is similar to a study carried out at Egypt by Mahfouz et al. which showed that an interval of more than 5yrs does increase the risk of high blood pressure and hypertensive disorders of pregnancy such as pre-eclampsia [17]. A population-based cohort study carried out in Australia also showed significant effect between long interpregnancy interval and preeclampsia [18]. Interpregnancy interval is a modifiable risk factor. Association between HDP and long interpregnancy interval could be due to advanced maternal age and maternal physiologic regression.

Conclusion

This study helped us in determining demographic and clinical risk factors that may be present at time of antenatal booking in rural women of central India. The profile of women in rural part of central India is different from urban population and other areas of India. India being a developing country, its pregnant population is also different from pregnant population of developed countries. A multitude of risk factors could be evaluated through this study, and their contribution to development of hypertension could be adjudged. Through this study, we now know which modifiable high risk factor should be targeted for a better maternal and neonatal outcome in these women.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s13224-024-02027-y.

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Declarations

Conflict of interest None declared.

Ethical Approval It was obtained from Institutional ethics committee of our institute. The research was accomplished in agreement with ethical norms as laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed Consent It was taken from each study subject.

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